CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

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SECTION A. General description of project activity

A.1 Title of the project activity:
Reduction in Ordinary Portland Cement consumption in concrete mix preparation utilizing lower cement concrete technology.

A.2. Description of the project activity:
The project activity proposes to reduce quantum of Ordinary Portland Cement (OPC) used during concrete mix production in different construction applications of the Hindustan Construction Company Limited (HCC). It promotes, establishes and implements a new technology called the lower cement concrete technology (LCCT) which involves:

(1) use of high range water reducing admixtures to decrease the OPC content in concrete mix and (if permitted by client),

(2) further decrease the OPC content in the concrete mix obtained under (1) through partial replacement with alternate cementitious materials like fly ash.

Through application of this technology, overall decrease in the requirement for OPC content in HCC's construction applications will be effected in the project activity.

In order to reduce the OPC content in concrete mix production, as intended above, the project will involve the following activities:

1. preparing concrete mix using LCCT with reduced quantity of OPC;
2. completing research and development (R&D) to establish the reliability of the LCCT;
3. promoting the new technology to clients;
4. information dissemination on the benefits of the LCCT through seminars, conferences and workshops;
5. providing specific training to the R&D, marketing and concrete production personnel;
6. identifying potential sources of replacement material(s), and identifying the baseline OPC consumption requirements for each concrete grade and application;
7. transportation, storage and processing of replacement material(s);
8. conducting quality assurance/ quality control (QA/QC) checks for the replacement material(s); and
9. conducting additional QA/QC checks for the concrete mix(es) prepared using the LCCT to establish confidence in this new technology.

The project proponent intends to implement the project activity on construction activities at 11 locations for which concrete mix preparation sites have been identified later (section A.4.1.4).

A.3. Project participants:
>> Project participants in this project activity are the project sponsor, the project advisor and a buyer(s) of the emission reduction units from Parties included in Annex I.

The project sponsor is the Hindustan Construction Company Limited. It is one of the pioneer construction companies in India with a 78-year old presence in the country. It also has an application oriented and research based practice that has led to prestigious and high value construction activities in India and abroad. HCC is a Rs. 1,000 crore entity with annual revenue of Rs. 1,171 during 2003-04. It is certified under ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999.

HCC has appointed PricewaterhouseCoopers (P) Ltd. (PwC) to be the advisor for this project activity. PwC is assisting the HCC in developing the Project Design Document (PDD) and is guiding it through the CDM project cycle, including technical assistance during the Host Government Approval and validation processes. PwC, formed by the global merger of Price Waterhouse and Coopers & Lybrand in 1998, is the world's largest financial and professional services organisation with 125,000 people in 142 countries and 867 offices worldwide. The contact details of HCC and PwC are provided at **Annex 1**.

The potential Parties to be involved from Annex I countries (buyers of emission reduction units) at a later date would be identified in the PDD prior to submission of the project details for registration.

HCC shall be the principal contact for the CDM project activity.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

The Government of India.

A.4.1.2. Region/State/Province etc.:

The project activity will be implemented across 11 construction sites of HCC spread across India, as mentioned earlier under section A.4.1.4. The states are Andhra Pradesh, Assam, Bihar, Rajasthan, Tamilnadu and Maharashtra.

A.4.1.3. City/Town/Community etc:

As mentioned earlier under section A.2.

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The project activity is uniquely identified by the location of concrete mix preparation locations for corresponding construction projects, as per the list provided below:

Sr. No.	Construction Project	Location of project activity
1.	Allahbad Bypass Project	Atrampur, Nawabganj (Uttar Pradesh.)
2.	Paradeep Road Project	Chandikhole, Dharamashala (Orissa)
3.	Rajasthan Road Project RJ7	Tejpur Bypass, (Rajasthan)
4.	Gosikhurd Dam	Pauni Taluka, Bhandara (Maharshtra)
5.	Polavaram Project	Srinivaspuram (Andhra Pradesh)
6.	Rajasthan Atomic Power Project	Anushakti, Rawatbhata (Rajasthan)
7.	Kudankulam Nuclear Power Project	Kudankulam, Radhapuram Taluk (Tamilnadu)
8.	Bandra Worli Sea Link Project	Bandra Reclamation Bus Stop, Bandra (Maharashtra)
9.	Munger Bridge Project	Ganga Bridge,Near Munger Railway station (Bihar)
10.	LAVASA Project	Mose valley,Taluka Mulshi and Velhe, Pune (Maharashtra)
11.	Boghibeel	Boghibeel, Debrugarg (Assam)

A.4.2. Category(ies) of project activity:

The project activity is applicable to 'Category 6 that relates to construction industry'. In the absence of an appropriate project category definition, a new project category has been considered titled *"substitution of GHG intensive materials in concrete mix preparation"*.

A.4.3. Technology to be employed by the project activity:

The LCCT helps in improving the consistency and workability of fresh concrete mix. Because of the additional fines present in such concrete mix, the amount and rate of bleeding and heat of hydration of the concrete is reduced. With the supplementary cementitious material present, the rate of strength gained is lower initially, but the strength grows continuously over a reasonable period to reach the target acceptable strength. The LCCT can be utilized in the following projects or type of structures:

a) laying rigid pavements;
b) production of kerb concrete;
c) roller compacted concrete for dams and roads;
d) production of high strength and high performance concrete (above M40 grade concrete); and
e) all other similar applications in concrete.

As mentioned under A.2, the materials that will be used in the project activity are admixtures (procured from market) and fly ash (solid wastes from coal-fired thermal power plants).

The three main advantages of adopting the LCCT are: (1) partially replacing the cement with supplementary cementitious material (fly ash), (2) improving the quality of the concrete and (3) environmental benefits due to reduction of OPC requirement (resulting in avoidance of equivalent OPC production). This technology minimizes the OPC content in concrete mix through two main ways:

1. using high range water reducing admixtures, reducing cement content by 10 to 20% in concrete; and

2. using fly ash as the supplementary cementitious material, reducing cement content by further 20 to 45% in concrete.

The need for having a guideline for mix design considering puzzolonas and admixture is felt due to the following limitations in IS 10262: 1982:

✓ does not account for admixtures usage; and

✓ do not provide a guide for relationship between water to cementitious material ratio and strength.

In order to establish the above, the HCC's R&D Center is working, as part of this project activity, to establish a standard guideline on working methodology with LCCT.

The mix design proportioning using the LCCT would involve the following steps:

Step 1 Select the consistency;
Step 2 Select maximum size of aggregate;
Step 3 Select the percentage of fly ash to total cementitious material;
Step 4 Determine the Water/ Cementitious material ratio by weight required for the desired compressive strength;

Step 5 Select the approximate quantity of mixing water needed for very stiff consistency and maximum size of aggregate (MSA) based on percentage of Fly Ash;
Step 6 Calculate the cementitious material content;
Step 7 Select the proportion of coarse aggregate;
Step 8 Select the proportion of fine aggregate;
Step 9 Modify the aggregate proportioning to suit maximum density and recommended combined grading;
Step 10 Select the dosage of admixture; and
Step 11 Trial mixtures – field trial.

The factors that will be considered for application of the LCCT will be the following:

Applications	Fresh concrete requirements	Hardened concrete requirements	Factors to be considered for mix design and optimization of OPC
Pavement concrete	✓ Slump 20-40 mm ✓ Retardation as per the lead	✓ To satisfy required characteristic strength at specified age	✓ Requirement of minimum fines for cohesiveness for slip forming and surface texturing ✓ Requirement of flexural strength ✓ Dosage of admixture for required retention ✓ Optimum replacement of OPC with fly ash (35-40%)
Kerbs	✓ Slump 20-40 mm ✓ Retardation as per the lead	✓ To satisfy required characteristic strength at specified age	✓ Requirement of minimum fines for cohesiveness for slip forming ✓ Optimum replacement of OPC with fly ash (40-50%)
Roller compacted concrete pavements	✓ Zero slump	✓ To satisfy required characteristic strength at specified age	✓ Requirement of fines for paste volume ✓ Optimum replacement of OPC with fly ash (40-50%)

Applications	Fresh concrete requirements	Hardened concrete requirements	Factors to be considered for mix design and optimization of OPC
Dam concrete/ Mass Concrete	✓ Slump 25-50 mm	✓ Controlling maximum temperature of concrete ✓ To satisfy required characteristic strength at specified age	✓ Control of heat of hydration ✓ Optimum replacement of OPC with fly ash (60-70%)
Roller compacted dam	✓ Zero slump	✓ Controlling maximum temperature of concrete to satisfy required characteristic strength at specified age	✓ Control of heat of hydration ✓ Dosage of admixture for required setting time ✓ Optimum replacement of OPC with fly ash (60-70%)
Self compacting concrete	✓ To satisfy the test requirements as specified in EFNARC[1]	✓ To satisfy required characteristic strength at specified age	✓ Requirement of fines to satisfy minimum fines ✓ Requirement of total water content in the mix ✓ Adjust doses of superplasticizers and VMA[2] for fresh concrete properties ✓ Optimum replacement of OPC with fly ash (40-60%)
Bridge substructure concrete	✓ Slump as per placing arrangements ✓ Retention as per open time requirement ✓ Anti-wash properties for underwater concrete.	✓ To satisfy required characteristic strength at specified age.	✓ Requirement of fines if concrete is to be pumped or for underwater concrete ✓ Adjust doses of admixtures to get suitable workability and retention ✓ Optimum replacement of OPC with fly ash (30-35%).

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

The project activity will lead to reduction in OPC usage with respect to baseline OPC usage requirements as per prescribed standards/ guidelines and protocols in the construction industry. The avoidance of usage in certain quantity of OPC will reduce greenhouse gas (GHG) emissions during OPC manufacturing from the quantity of cement saved due to this reduction in consumption. The principal

[1] European federation for specialist construction chemicals and construction systems.

[2] Viscosity Modifying Agent.

GHG emissions saved in cement manufacturing is carbon dioxide (CO_2), though minor quantities of nitrous oxide (N_2O) and methane (CH_4) are also emitted. CO_2 is emitted both from manufacturing process as well as due to burning of fuels to meet the energy requirements of the manufacturing processes, and these are accounted in the CO_2 emission intensity data obtained from authorized national level data source adopted in this project activity.

The implementation of the project activity will result in large-scale reduction of OPC consumption at HCC's construction projects thereby reducing the demand for OPC in HCC's construction activities. The reduction in such demand will reduce the manufacture of OPC thereby also reducing emission of CO_2.

In the absence of the proposed project activity, OPC will continue to be manufactured at baseline requirements to meet HCC's construction requirements resulting in release of CO_2 emissions.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

The project activity involves concrete mix preparation at 11 locations for a period of 3 years (2005 – 2007) fixed crediting period. The estimated emission reductions during the crediting period will be 249462 tCO_2.

A.4.5. Public funding of the project activity:

This project activity has been taken up as a unilateral project and no public funding is proposed for it at the present time.

SECTION B. Application of a baseline methodology

B.1. Title and reference of the approved baseline methodology applied to the project activity:

In the absence of an approved methodology, a proposed new baseline methodology has been adopted for this project named *"Reduction in the use of Ordinary Portland Cement for concrete mix preparation"*.

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

The new baseline methodology is applicable to this project activity because:

- ✓ project activity involves reduction in OPC use for the preparation of concrete mix in a variety of construction applications, by substituting part of OPC content in concrete mix with alternate materials of less GHG intensity;
- ✓ there are no existing regulations/ legislation that encourage or prohibit the reduction in OPC content in concrete mix preparation;
- ✓ the project activity do not directly control baseline emission, project emission or emission reduction in OPC production process; it indirectly results in avoiding the need to produce more OPC in the cement industry, thereby avoiding CO_2 emissions from OPC manufacturing processes; and
- ✓ concrete mix prepared by the project activity would not adversely impact the functionality of the concrete mix to be prepared using LCCT, and is in compliance with applicable standards/ guidelines etc., on the functional characteristics of concrete mix.

B.2. Description of how the methodology is applied in the context of the project activity:

The project activity will involves implementation of a technology that will result in reduction the OPC requirement in concrete mix preparation, thereby avoiding production of the quantity of OPC avoided and associated emission of CO_2. It will also encourage other construction companies to undertake similar savings in future.

In order to justify that the project activity is not a baseline scenario, the following additionality analysis has been performed as per details prescribed in the adopted baseline methodology:

Step 0 Preliminary screening of projects started after 1 January 2000 and before 31 December 2005

The initial activities such as technology identification and assessment, and identification of concrete mix preparation locations where the project activity will be implemented have been initiated. The HCC management has taken a conscious decision to adopt the project activity at its concrete mix preparation locations considering the benefits of CDM revenue to the project activity, and the documents such as feasibility report and minutes of management review meetings are available for verification by the validator. The construction activity under the project is planned to be started from January 2005. Since, the additionality demonstration has crossed step 0, it may proceed to step 1.

Step 1 Demonstrating that the project activity is not mandated under current laws and regulations

The project activity is neither a requirement under the construction industry guidelines in India nor a requirement as per any current environmental legislation.

In comparison to the project activity, the baseline scenario of is in line with regulations and construction industry guidelines.

Since, the additionality demonstration has crossed step 1, it may proceed to step 2.

Step 2 Investment Analysis

The current/ prevalent practice (i.e., baseline scenario) is a better financial alternative since payment from the client[3] is based on the quantity of OPC used in concrete mix. By implementing the project activity, the total quantity of OPC used will be reduced resulting in discounted returns[4] from the client. Also the cost of admixture used is very high, and the client does not bear such additional costs. In addition to this, there will be associated costs for R&D and additional quality assurance/ quality control (QA/QC) checks on fly ash, concrete mix, etc., promotion, new equipment and logistics.

Such additional costs are non-existent in the baseline scenario (i.e., continue using standard quantity of OPC as per regulations and construction industry guidelines).

Thus, overall the project is not attractive without the CDM revenue.

Since, the additionality demonstration has crossed step 2, it may proceed to step 4 or to step 3.

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[3] Customer in whose application HCC would provide concrete mix for construction purposes.

[4] Payment/ revenue will be reduced in proportion to quantity of OPC reduced in comparison to baseline requirements of OPC.

Step 3 Barrier Analysis
The barrier analysis could be completed based on the following arguments:

Investment:	The HCC management perceived risks to their investment due to unfamiliarity with and non-prevalence of the new technology, and risks to investments on associated R&D and promotional activities, training, equipment procurement and actual procurement of additional and replacement materials, and loss of revenue from client due to use of lesser quantity of OPC.
Technological:	The new technology has been developed in-house by the HCC. The reliability of this technology, to provide similar results as provided by normal use of OPC in the baseline scenario, needs to be established across all concrete mix preparation locations and applications resulting in a technological barrier. HCC is planning and including appropriate R&D activities and QA/QC procedures, for fly ash, admixtures and concrete mix prepared with this new technology, to overcome such barrier.
Prevalence:	There is no established public document to evidence that such a project activity has been performed at the proposed scale anywhere in the Indian construction industry sector. Hence, the current and potential clients are often sceptical about the reliability and success of the project activity. However, the project activity through implementing the new technology in a larger scale at several of its construction projects would make this a prevalent practice.

Since, the additionality demonstration has crossed step 3, it may proceed to step 4.

Step 4 Common Practice Analysis
The project activity is not a common practice in the country. The project activity, through large-scale implementation at several locations across India over a 10-year crediting period, can make this a common practice.

Since, the additionality demonstration has crossed step 4, it may proceed to step 5.

Step 5 Impact of CDM Registration
Based on the above analysis, it is apparent that the project activity is neither a financially attractive proposition nor a prevalent/ common practice. The technology involved is also new and the project activity will establish its reliability. The project activity will help in overcoming all such barriers using CDM revenue as an incentive to this endeavour. Hence, the project is additional to the baseline scenario.

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

In the absence of the project activity, HCC would have used normal/ standard quantities of OPC at its concrete mix preparation locations. Such quantity of OPC usage constitutes the baseline scenario. Due to the demand of bulk requirement of OPC by HCC, a demand for such quantity of OPC production would have generated in the market, resulting in the cement industry producing such quantities of OPC to meet the demand.

Due to the project activity, generation of such large-scale demand would be avoided, and the cement industry would not be required to produce the baseline quantity of OPC. Hence, equivalent[5] quantum of CO_2 release to the environment will be avoided, since production of OPC is associated with emission of CO_2 to the atmosphere.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

The project activity is multi-locational, covering 11 construction projects of HCC, as indicated earlier in this PDD (refer section A.4.1.4). The project boundary includes the concrete mix preparation locations for each of these 11 sites, where direct control on use of quantity of OPC can be exercised. By directly controlling the requirement of OPC at these project sites, production of OPC by equivalent quantity, is avoided at the OPC producing plants identified for supply of OPC to the individual concrete mix preparation location.

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

Dr. P Ram Babu of PricewaterhouseCoopers (P) Limited, whose contact information is set out in Annex 1 has assisted the project proponent in determining the baseline methodology. The annexed proposed baseline methodology determination has been completed on 18 April 2005.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

January 2005.

C.1.2. Expected operational lifetime of the project activity:

At least 3 years since January 2005.

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

>> Not opted for.

C.2.1.2. Length of the first crediting period:

>> Not applicable.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

January 2005.

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[5] In proportion to OPC production avoided due to the project activity.

C.2.2.2. Length:

3 years.

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

In the absence of an approved monitoring methodology, a new monitoring methodology named *"Reduction in the use of Ordinary Portland Cement for concrete mix preparation"* has been adopted.

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The monitoring methodology is in line with the adopted baseline methodology and its applicability conditions, and hence justifies its choice to the project activity.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
$RA_{Ci,G,Y}$	Reduced proportion of OPC in unit volume of concrete mix in application 'G' during year 'Y'	Relevant concrete mix preparation location's records	tonnes/ cubic meters	m	Annual	Daily results for entire year	electronic	For all grades G at all locations Ci, and for all years during the crediting period.
$RV_{Ci,G,Y}$	Gross volume of concrete produced for use in application 'G' during year 'Y'	Relevant concrete mix preparation location's records	cubic meters	m	Annual	Daily results for entire year	electronic	For all grades G at all locations Ci, and for all years during the crediting period.
$RAA_{Cj,G,Y}$	Reduced proportion of OPC in unit volume of concrete mix in application 'G' during year 'Y'	Relevant concrete mix preparation location's records	tonnes/ cubic meters	m	Annual	Daily results for entire year	electronic	For all grades G at all locations Cj, and for all years during the crediting period.
$RVA_{Cj,G,Y}$	Gross volume of concrete produced for use in application 'G' during year 'Y'	Relevant concrete mix preparation location's records	cubic meters	m	Annual	Daily results for entire year	electronic	For all grades G at all locations Cj, and for all years during the crediting period.

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
$RAC_{Ck,G,Y}$	Reduced proportion of OPC in unit volume of concrete mix in application 'G' during year 'Y'	Relevant concrete mix preparation location's records	tonnes/ cubic meters	m	Annual	Daily results for entire year	electronic	For all grades G at all locations C_k and for all years during the crediting period.
$RVC_{Ck,G,Y}$	Gross volume of concrete produced for use in application 'G' during year 'Y'	Relevant concrete mix preparation location's records	cubic meters	m	Annual	Daily results for entire year	electronic	For all grades G at all locations C_k and for all years during the crediting period.
Ci	All concrete mix preparation locations where the project activity is proposed during year 'Y', using only admixtures in concrete mix along with OPC and other standard constituents	Relevant concrete mix preparation location's records	--	m	Annual	Annual	electronic	i = 1, 2,…n, and for all years during the crediting period.
Cj	All concrete mix preparation locations where the project activity is proposed during year 'Y', using both admixtures and alternate cementitious materials in concrete mix along with	Relevant concrete mix preparation location's records	--	m	Annual	Annual	electronic	j = 1, 2,…n, and for all years during the crediting period.

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
	OPC and other standard constituents							
C_k	All concrete mix preparation locations where the project activity is proposed during year 'Y', using fly ash only along with OPC and other standard constituents	Relevant concrete mix preparation location's records	--	m	Annual	Annual	electronic	k= 1, 2,…n, and for all years during the crediting period.

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

The reduction of use of OPC through the new technology could be effected under the project activity through the first stage or second stage or first stage followed by second stage, as described below.

Stage 1: Adding a high range water reducing admixture to the concrete mix thereby reducing the requirement of OPC; and/or

Stage 2: Using alternate cementitious materials to partially replace the balance requirement of OPC in the concrete mix.

For step 1 (wherein only admixture is used in the concrete mix), the requirement for OPC ($PA_{Ci,G,Y}$ *in tonnes*) at concrete mix preparation location 'Ci' for concrete mix grade 'G' during year 'Y', will be calculated as follows:

$$PA_{Ci,G,Y} = RA_{Ci,G,Y} * RV_{Ci,G,Y} \quad \text{……………………………………………(1)}$$

The total quantity of OPC that would have been used for all grades of concrete mixes to be used (G = 1, 2, ……) across several applications at concrete mix preparation location 'Ci' during year 'Y' will be calculated by adding the individual usages in several grades:

$PA_{Ci,Y} = \Sigma\ PA_{Ci,G,Y}$………………………………………………………..(2)

For step 2 (wherein both admixture and alternate cementitious material are added in the concrete mix), the requirement for OPC ($PAA_{Cj,G,Y}$ *in tonnes*) at concrete mix preparation location 'Cj' for concrete mix grade 'G' in which admixture has already been used during year 'Y,' will be calculated as follows:

$PAA_{Cj,G,Y} = RAA_{Cj,G,Y} * RVA_{Cj,G,Y}$…………………….……………….(3)

The total quantity of OPC that will be used for all grades of concrete mixes (G = 1, 2, ……) across several applications at concrete mix preparation location 'Cj' during year 'Y' will be calculated by adding the individual usages in several grades:

$PAA_{Cj,Y} = \Sigma\ PAA_{Cj,G,Y}$……………………………………………..(4)

For step 3 (wherein only alternate cementitious material are added in the concrete mix), the requirement for OPC ($PAC_{Ck,G,Y}$ *in tonnes*) at concrete mix preparation location 'C_k' for concrete mix grade 'G' in which admixture has already been used during year 'Y,' will be calculated as follows:

$PAC_{Ck,G,Y} = RAC_{Ck,G,Y} * RVC_{Ck,G,Y}$……………….…………….(5)

The total quantity of OPC that will be used for all grades of concrete mixes (G = 1, 2, ……) across several applications at concrete mix preparation location 'C_k' during year 'Y' will be calculated by adding the individual usages in several grades:

$PAC_{Ck,Y} = \Sigma\ PAC_{Ck,G,Y}$……………………………………………..(6)

During any year 'Y' the gross volume of concrete produced ($V_{C,G,Y}$) for use at all concrete mix preparation locations 'C' needs to conform to the following checks in relation baseline cement reduction calculations:

$V_{C,G,Y} = RV_{Ci,G,Y} + RVA_{Cj,G,Y} + RVC_{Ck,G,Y}$ …………………………....(7)

Considering the CO_2 emission factor for OPC production to be EF_{PC} *(in tonnes CO_2 emitted per tonne of cement produced)*[6], the annual emission (PL_{PC} *in tonnes*) of CO_2 in spite of the project activity is calculated as follows, using summation over all concrete mix preparation locations considered within the project boundary:

[6] Calculated as per procedure shown in equation (13) under section D.2.1.4.

$$PL_{PC} = \sum (EF_{PC} * PA_{Ci,Y}) \quad \text{..} (8)$$

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
$BC_{C,G,Y}$	Proportion of OPC in unit volume of concrete mix in application 'G' during year 'Y'	Project sponsors database	tonnes/ cubic meters	e	Annual	Once for all applications and grades unless additional monitoring are warranted	electronic	For all grades 'G' at all locations 'C' where reduction in use of OPC is planned for implementation, and for all years during the crediting period.
$V_{C,G,Y}$	Gross volume of concrete produced for use in application 'G' during year 'Y'	Relevant concrete mix preparation location's records	cubic meters	m	Annual	Daily results for entire year	electronic	For all grades 'G' at all locations 'C' where reduction in use of OPC is planned for implementation, and for all years during the crediting period.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
C	All concrete mix preparation locations where the project activity is proposed during year 'Y', using either admixtures or fly ash or both admixtures and fly ash in concrete mix along with other standard constituents	Relevant concrete mix preparation location's records	--	m	Annual	Annual	electronic	For all years during the crediting period.
EF_{PC}	Emission factor for OPC manufacturing in India	Central Pollution Control Board	tCO_2/ tonne of OPC produced	e	Annual	Annual	electronic	CO_2 emission factor for OPC production in the Indian cement industry, as reported in the recent data published in "Parivesh (Newsletter published by the Central Pollution Control Board)"[7]

[7] http://www.cpcb.delhi.nic.in/globel/ch7oct02.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
Q_{fuel}	Annual quantity of (all) fuel(s) used in any OPC producing plant during a year prior to start of project activity crediting period	Annual Report and Official we-site information	Tonnes	e	Annual	Annual	electronic	NA
Q_{OPC}	Annual quantity of OPC produced in the corresponding OPC producing plant (mentioned above) during a year prior to start of project activity crediting period	Annual Report and Official we-site information	Tonnes	e	Annual	Annual	electronic	NA
NCV_{fuel}	Net Calorific value of fuel (as mentioned above)	IPCC	TJ/ 10^3 tonnes	e	NA	NA	electronic	NA
CEF_{fuel}	Carbon emission factor for fuel used as above	IPCC	tonnes C/ TJ	e	NA	NA	electronic	NA
COF_{FUEL}	Carbon oxidation factor for fuel used as above	IPCC	NA	e	NA	NA	electronic	NA

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

The baseline scenario involves quantity of OPC that would have been used in a particular grade or application of concrete mix under normal concrete mix design specifications for such application. Hence, at any concrete mix preparation location 'C' during a year 'Y', the quantity of OPC ($PB_{C,G,Y}$ *in tonnes*) that would have been used in grade 'G' of concrete mix in the absence of the project activity would be calculated as follows:

$$PB_{C,G,Y} = BC_{C,G,Y} * V_{C,G,Y} \quad \text{……………………………………………….(9)}$$

The total quantity of OPC that would have been used for all grades of concrete mixes to be used (G = 1, 2, ……) across several applications at concrete mix preparation location 'C' during year 'Y' will be calculated by adding the individual usages in several grades:

$$PB_{C,Y} = \Sigma\ PB_{C,G,Y} \quad \text{……………………………………………………..(10)}$$

Estimation of CO_2 Emission Factor (ex – ante) due to OPC production

For calculating the emission factor (**EF_{PC}**) for ex-ante estimation of baseline emissions, publicly available data on the same from any national level authority could be used. The same needs to be updated ex-post for each crediting year of the project activity.

Estimation of CO_2 Emission Factor (ex – post) due to OPC production

The emission factor (**EF_{PC}**) for OPC manufacturing has been calculated using process related CO_2 emissions from production of clinkers and use of fuels for energy in the total OPC manufacturing process. For each concrete mix preparation location to be identified in the project boundary, a maximum of 4 nearest located OPC producing plants will be identified for sourcing. The emission factor relevant to each concrete mix preparation location will be calculated as average emission factor for the corresponding OPC producing plants. The same procedure will be repeated all concrete mix preparation plants identified in the project boundary.

The CO_2 emission factor (**$EF_{clinker}$**) for clinker production could be used from any authentic National level official database such as National Communications by the Host Country, etc.

The CO_2 emission factor (**EF_{fuel}**) due to use of fuels in OPC manufacturing process could be used from any authoritative national level sector-wise average for CO_2 emission due to use of fuels in OPC manufacturing process or calculate the same using plant-wise fuel consumption data and IPPC data on emissions for different fuels. If calculated plant-wise, the following algorithm will be used.

$$EF_{fuel} = \Sigma\ (Q_{fuel} * NCV_{fuel} * CEF_{fuel} * COF_{fuel} * 44/12)\ /\ \Sigma\ (Q_{OPC}) \quad \text{…………………………..(11)}$$

Hence, the CO_2 emission factor (**EF_{PC}**) is calculated as:

$EF_{PC} = EF_{clinker} + EF_{fuel}$……………………(12)

Using EF_{PC} *(in tonnes CO_2 emitted per tonne of OPC produced)*, the annual baseline emission (BL_{PC} *in tonnes*) of CO_2 is calculated as, using summation for all concrete mix preparation location considered within the project boundary:

$BL_{PC} = \sum (EF_{PC} * PB_{C,Y})$ ………………………………………………..…(13)

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

>> Not applicable.

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
Not applicable.								

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

>> Not applicable.

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
Q_{OPC_BL}	Quantity of OPC transported from cement procuring sources to concrete mixing locations in the baseline scenario	Project proponents database	tonnes	e	Annual	Annual	electronic	To be recorded separately for each location of concrete mix preparation within project boundary, and each source of OPC for such location.
Q_{OPC_PA}	Quantity of OPC transported from cement procuring sources to concrete mixing locations in the project activity scenario	Project proponents database	tonnes	e	Annual	Annual	electronic	Same as above.
TC	Truck capacity	Project proponents database	tonnes	e	Annual	Annual	electronic	Same as above.

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
AVD	Average return trip distance between the OPC or 'Replacement Material' procuring sources and corresponding locations for concrete mix preparation	Project proponents database	km	e	Annual	Annual	electronic	Same as above.
TEF	CO_2 emission factor for the trucks	Project proponents database	tCO_2/km	e	Annual	Annual	electronic	Same as above.

The leakage emissions could occur if the transportation needs for sourcing both OPC and replacement materials (in the project activity scenario) are greater than the transportation needs for sourcing only OPC (in the baseline scenario). In such an event, the leakage emissions due to additional transportation needs will be calculated as per the following provided under section D.2.3.2, using the data variable indicated above. In this PDD, leakage emissions are assumed to be nil, as per ex-ante situation; however, this may be updated each year of the crediting period based on ex-post data and calculations.

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

For ex-post calculation of leakage emissions, the following formula would be used.

Transportation needs (number of trucks required for transportation) for OPC in the baseline scenario:

$BL_{TRANS} = Q_{OPC\_BL} / TC$……………………………..(14)

Transportation needs (number of trucks required for transportation) for OPC and 'Replacement Material in the project activity scenario':

$PA_{TRANS} = (Q_{OPC\_PA} + Q_{RM\_PA}) / TC$……………………………..(15)

If **PA_{TRANS} > BL_{TRANS}**, then leakage emissions (**LE_{TRANS}**) will occur, that may be calculated as per the following formula, accounting for all concrete mix preparation locations identified in the project boundary.

$LE_{TRANS} = \sum [(PA_{TRANS} - BL_{TRANS}) * AVD * TEF]$……………………..…(16)

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Based on the algorithm provided earlier for baseline and project scenarios, the annual emission reduction has been calculated as per the following formula:

$ER_Y = BL_{PC} - PL_{PC}$ ……………………………………………………………(17)

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
$RA_{Ci,Gx,Y}$ (Table D.2.1.1)	Low	QA/QC protocols on measurement processes and equipment calibration as per ISO 9001: 2000 requirements for HCC will be used.
$RV_{Ci,Gx,Y}$ (Table D.2.1.1)	Low	Same as above.
$RAA_{Cj,Gy,Y}$ (Table D.2.1.1)	Low	Same as above.
$RVA_{Cj,Gy,Y}$ (Table D.2.1.1)	Low	Same as above.
$RAC_{Cj,Gy,Y}$ (Table B.2.1)	Low	QA/QC protocols on measurement processes and equipment calibration to be used.
$RVC_{Cj,Gy,Y}$ (Table B.2.1)	Low	QA/QC protocols on measurement processes and equipment calibration to be used.

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
$BC_{C,G,Y}$ (Table D.2.1.3)	Low	QA/QC not required, as this will be estimated on the basis of standard published protocols.
$V_{C,G,Y}$ (Table D.2.1.3)	Low	QA/QC protocols on measurement processes and equipment calibration as per ISO 9001: 2000 requirements for HCC will be used.
Q_{fuel} (Table D.2.1.3)	Low	Official/ authentic data of OPC producer has been used, and hence no separate QA/QC is required.
Q_{OPC} (Table D.2.1.3)	Low	Same as above.

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

Each concrete mix preparation location, for design and construction as per new technology, will be covered under the standard QA/QC practices and ISO 9001: 2000 procedures laid down for the entire company (HCC). All project data on standard usage requirements of OPC at each concrete mix preparation location based on application and grade of concrete mix and actual use of OPC in reduced quantities, will be monitored as per standard internal protocols followed and used by HCC in its construction activities. Hence, data quality is assured and controlled. Such data will be used for estimating the emission reductions making the process reliable, conservative and transparent.

D.5 Name of person/entity determining the monitoring methodology:

Dr. P Ram Babu of PricewaterhouseCoopers (P) Limited, whose contact information is set out at Annex 1 has assisted the Project Proponent in determining the monitoring methodology.

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

The annual CO_2 emissions by sources will be 195,853 tCO_2 during year 2005, 195,853 tCO_2 during year 2006 and 97,926 tCO_2 during year 2007, aggregating to 489,632 tCO_2 during the chosen crediting period.

E.2. Estimated leakage:

The leakage due to transportation is assumed to be nil; however, the same may be updated ex-post.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

The annual CO_2 emissions for the project activity will be 195,853 tCO_2 during year 2005, 195,853 tCO_2 during year 2006 and 97,926 tCO_2 during year 2007, aggregating to 489,632 tCO_2 during the chosen crediting period.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

The annual CO_2 emissions for the baseline scenario will be 295,637 tCO_2 during year 2005, 295,637 tCO_2 during year 2006 and 147,819 tCO_2 during year 2007, aggregating to 739,094 tCO_2 during the chosen crediting period.

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

The annual CO_2 emission reduction for the project activity will be 99,785tCO_2 during year 2005, 99,785 tCO_2 during year 2006 and 49,892 tCO_2 during year 2007, aggregating to 209,462 tCO_2 during the chosen crediting period.

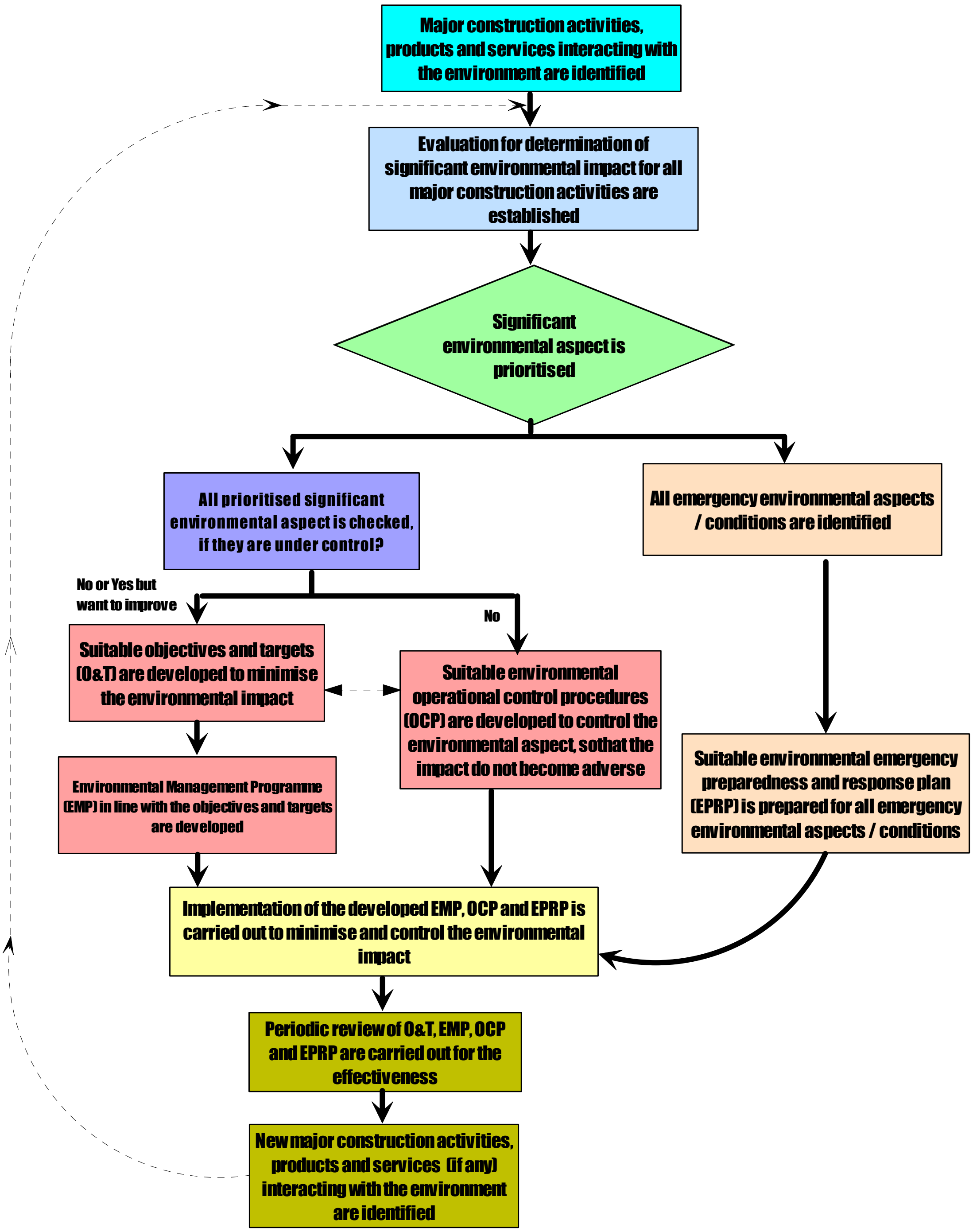
E.6. Table providing values obtained when applying formulae above:

Location for Concrete Mix preparation	Total quantity of OPC (tonnes) during		Emission Reduction (tCO_2) during 2005	Total quantity of OPC (tonnes) during 2006		Emission Reduction (tCO_2) during 2006	Total quantity of OPC (tonnes)		Emission Reduction (tCO_2) during 2007
	Baseline	Project Activity		Baseline	Project Activity		Baseline	Project Activity	
Total Annual Emission Reductions (tCO_2)	295637	195853	**99785**	295637	195853	**99785**	147819	97926	**49892**

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

As part of the environmental management system at HCC, the company continually assesses the impacts and management of all its activities, products and services covering the concrete mix preparations locations as well as materials that it uses. The impact evaluation and management steps are shown in the schematic provided below.



Also, in order to comply with the applicable legal requirements, the duly filled application form for obtaining ‘no objection certificate’ as per current environmental legislation is submitted to concerned State Pollution Control Board (SPCB) regional office for each and every location where concrete mix is prepared, respectively, prior to start the construction. The SPCBs issue consent to establish and consent to operate under air and water act annually, while the hazardous wastes authorization is issued with validity for five years. Legal update at each and every location is maintained and prior to expiry of any consent or authorization, it gets renewed till the project construction gets completed.

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

No significant impacts have been identified due to reduction in use of OPC. The project activity does not require obtaining any other regulatory clearance than those indicated under section F.1.

SECTION G. Stakeholders' comments

G.1. Brief description how comments by local stakeholders have been invited and compiled:

The stakeholder consultation process is under implementation. All stakeholders comprising representatives from the following organizations/ authorities and individuals were invited to participate in the process, and provide their inputs.

- ✓ Fly ash supplier(s)
- ✓ Admixture supplier(s)
- ✓ Construction contractor(s)
- ✓ Central and State Pollution Control Boards
- ✓ Confederation of Indian Industries
- ✓ Cement Manufacturers' Association of India
- ✓ Local NGOs
- ✓ Share-holders
- ✓ Construction Research Institutes.

The project documents comprising the PDD, the adopted baseline and monitoring methodologies and project feasibility report (without confidential information of R&D results and costs) were hosted at a web location on the internet. The identified stakeholders were intimated electronically and by other means to report their comments, concerns and observations on the project activity to the HCC. The HCC also constituted a review committee to review and articulate the concerns and provide satisfactory replies to the queries posed.

G.2. Summary of the comments received:

Not available at this stage.

G.3. Report on how due account was taken of any comments received:

Not available at this stage.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is proposed for this project activity.

Annex 3

BASELINE INFORMATION

Sr. No.	Location for Concrete Mix preparation	EF_{PC} (in tCO_2 / tonne of OPC)	Total quantity of OPC (tonnes) during 2005		Emission Reduction (tCO_2) during 2005	Total quantity of OPC (tonnes) during 2006		Emission Reduction (tCO_2) during 2006	Total quantity of OPC (tonnes)		Emission Reduction (tCO_2) during 2007
			Baseline	Project Activity		Baseline	Project Activity		Baseline	Project Activity	
1	Atrampur, Nawabganj	0.9	50970	44840	5517	50970	44840	5517	25485	22420	2759
2	Chandikhole,Dharamashala	0.9	11974	10372	1442	11974	10372	1442	5987	5186	721
3	Tejpur Bypass	0.9	50856	45640	4694	50856	45640	4694	25428	22820	2347
4	Pauni Taluka, Bhandara	0.9	16800	7050	8775	16800	7050	8775	8400	3525	4388
5	Srinivaspuram	0.9	62522	40181	20107	62522	40181	20107	31261	20091	10053
6	Anushakti, Rawatbhata	0.9	12982	5937	6341	12982	5937	6341	6491	2968	3170
7	Kudankulam, Radhapuram Taluk	0.9	2076	1787	260	2076	1787	260	1038	893	130
8	Bandra Reclamation Bus Stop, Bandra	0.9	15618	9168	5805	15618	9168	5805	7809	4584	2903
9	Ganga Bridge,Near Munger Railway station	0.9	38631	13321	22779	38631	13321	22779	19315	6660	11390
10	Mose valley,Taluka Mulshi and Velhe, Pune	0.9	7500	5325	1958	7500	5325	1958	3750	2663	979
11	Boghibeel, Debrugarg	0.9	58558	33994	22108	58558	33994	22108	29279	16997	11054
	Total Annual Emission Reductions (tCO_2)				**99785**			**99785**			**49892**

Annex 4

MONITORING PLAN

Provided under section D.

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